



# National Transportation Safety Board

Office of Railroad, Pipeline and Hazardous Materials Investigations

Washington, D.C. 20594

Signal and Train Control Factual Report

**Rear-End Train Collision on the Norristown High Speed Line**

**Southeastern Pennsylvania Transportation Authority**

**69<sup>th</sup> Street Transportation Center – Upper Darby Township, Pennsylvania**

**August 22, 2017**

**DCA 17 FR 012**

Rear-End Train Collision on the Norristown High Speed Line  
Southeastern Pennsylvania Transportation Authority  
69th Street Transportation Center – Upper Darby Township, Pennsylvania August 22, 2017

**A. ACCIDENT**

**Type:** Rear-End Train Collision on the Norristown High Speed Line  
**Date and Time:** August 22, 2017 at 12:11 a.m. EST  
**Location:** 69<sup>th</sup> Street Transportation Center in Upper Darby, PA  
**Carrier:** Southeastern Pennsylvania Transportation Authority (SEPTA)  
**Train #1:** Train 155 (Striking Train)  
**Train #2:** Train 148 (Rear-Ended Train)  
**Fatalities:** 0  
**Injuries:** 42

**B. SIGNAL & TRAIN CONTROL - INVESTIGATIVE GROUP**

|  |  |
|--|--|
| R. Page                                | M. Monastero                             |
| Railroad Accident Investigator         | Chief Engineering Officer                |
| Office of Railroad, Pipeline, and Haz- | Communication & Signals                  |
| Mat Investigations                     | Southeastern Pennsylvania Transportation |
| National Transportation Safety Board   | Authority                                |

|                                |  |
|--------------------------------|--|
| Tim Shirk                      | J. Frisoli                               |
| Director of Signal Engineering | Director of Subway/Light Rail Signals    |
| Communication & Signals        | Communications & Signals                 |
| Southeastern Pennsylvania      | Southeastern Pennsylvania Transportation |
| Transportation Authority       | Authority                                |

|                           |                            |
|---------------------------|----------------------------|
| John Kaminski             | Dan Hauber                 |
| Signal Foreman            | Project Principal          |
| Communication & Signals   | Pennsylvania Department of |
| Southeastern Pennsylvania | Transportation             |
| Transportation Authority  |                            |

**C. ACCIDENT SUMMARY**

For a summary of the accident, refer to the Accident Summary within this docket.

**D. DETAILS OF THE INVESTIGATION**

**1. Description of Train Control System**

The Norristown High Speed Line is a two (2) track, 13 miles, 600 volts direct-current

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(VDC) electrically powered light rail line. The line operates regular light rail service between Norristown and Upper Darby Pa. The line operates frequent local and skip stop service to 22 light rail station between Norristown transportation center and 69<sup>th</sup> street terminal., seven days a week. The light rail; operations are governed by the instructions described in the document's Rail Operations manual and the document Surface operations manual-Suburban Victory Division Special instructions. The light rail traffic control system was installed in the mid-1990's and provide bi-directional operation utilizing a track circuit based, color light signal system providing movement authorities to the rail vehicles as described in rules RDR-362 to RDR 368 of the Rail Operations manual. Rule compliance is provided by a wayside signal system based on cab signaling that provides safe light rail vehicle separation, overspeed, and stop signal overrun protection.

The light rail on board- vehicle system provides compliance and enforcement by the way of an Automatic Train Control System (ATC) employing 5 cab signal codes, including;

| Code Rate | Maximum Allowable Speed |
|-----------|-------------------------|
| 420       | 70MPH                   |
| 270       | 55MPH                   |
| 180       | 45MPH                   |
| 120       | 30MPH                   |
| 50        | 15MPH                   |
| 0         | STOP                    |

There are eight remotely controlled interlockings on the line including NTC, Bridgeport, Hughes Park, Radnor, Bryn Mawr, Wynnewood, West Overbrook, and the main terminus 69<sup>th</sup> street. The interlockings utilize high voltage, electric switch and lock machines. There are three, manually operated, electric lock locations on the NHSL, King manor, Villanova, and Beechwood.

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The light rail Traffic Control System is managed and controlled by a Centralized Traffic Control system located on the 19<sup>th</sup> floor of 1234 market street, SEPTA building. The Light Rail Controller (Dispatcher) oversees line operations on a round the clock schedule 365 days a year. The NHSL CTC system also includes auto routing capabilities.

Wayside Signals, use color-light units capable of displaying the aspects listed in Table 1.

**Table 1 Interlocking Signals**

| <b>Name</b>                      | <b>Aspect</b>     | <b>Indication</b>   |
|----------------------------------|-------------------|---|
| RDR-362<br>Proceed Cab           | Solid Lunar       | Trains with operative cab signals proceed straight on main line route governed by cab signals. Trains without operative cab signals must stop and call Control Center for instructions  |
| RDR-363<br>Proceed Cab<br>Divert | Flashing<br>Lunar | Trains with operative cab signals, proceed on diverging route at speed governed by cab signals. Trains without  |
|                                  |                   | operative cab signals must stop and call Control Center for instructions.   |
| RDR-364 Stop<br>Signal           | Solid Red         | Stop and stay, call Control Center for instructions.  |
| RDR-365 Clear<br>Block           | Solid Green       | Trains without operative cab signal, proceed at maximum authorized speed not exceeding 30 mph, being prepared to stop at the next signal, trains with operative cab signals, proceed at speed governed by cab signals.  |
| RDR-366 Clear<br>Block Divert    | Flashing<br>Green | Trains without operative cab signals, proceed on diverging route at speed not exceeding 15 mph until diverging movement is complete. Then proceed at maximum authorized speed not exceeding 30 mph, being prepared to stop at the next signal; trains with operative cab signals, proceed at speed governed by cab signals. |

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**2. Wayside event recorder data**

Table 1 is a summary of the wayside signal event recorders data download.

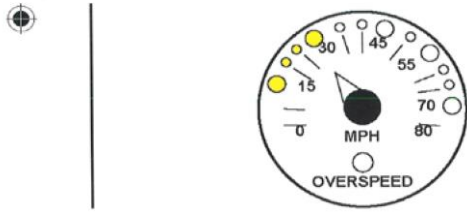

Table 1. Wayside Signal Event Data Log Summary

| <b>Time</b> | <b>Event</b> | <b>Correspondin<br/>g Cab Code<br/>Rate<br/><br/>Pulses Per<br/>Minute</b> | <b>On Board Cab Signal Indication</b> |
|-------------|--------------|--|---------------------------------------|
|-------------|--------------|--|---------------------------------------|

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|                 |   |           |  |
|-----------------|---|-----------|--|
| <p>12:08:29</p> | <p>Train 155 is occupying south approach on main track one at West Overbrook Interlocking. 1S signal has a signal indication of flashing lunar. The 21 X-over switch is lined reverse to allow a train to move from main track one to main track two. See figure - 1.</p> <p>Note : time adjusted 2min 4 sec to synchronize time with 69<sup>th</sup> street data recorder.</p> | <p>75</p> | <p><u>15 MPH</u><br/> Indication/Procedure: The 15 MPH aspect will illuminate. Train Operators must maintain a speed of 14 MPH or less.</p>  |
|-----------------|---|-----------|--|

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| Time     | Event   | Corresponding Cab Code Rate<br>Pulses Per Minute | On Board Cab Signal Indication   |
|----------|---|--|--|
| 12:10:26 | Train 155 is occupying the south approach of the 2S signal on main track two. The 2S signal is indicating Lunar. The on-board Cab signal code rate is 120 with an allowable speed of 30 MPH See Figure -2 | 120  | <p><b>30 MPH</b><br/> <b>Indication/Procedure:</b> All aspects up to and including the 30MPH aspect will illuminate. Train Operators must maintain a speed of 29 MPH or less.</p>  |
| 12:10:49 | Train 155 is occupying the south approach of the 4S signal on main track two. The 4S signal is indicating lunar. The On-board Cab signal code rate is 75 with an allowable                                | 75   | <p><b>15 MPH</b><br/> <b>Indication/Procedure:</b> The 15 MPH aspect will illuminate. Train Operators must maintain a speed of 14 MPH or less.</p>                               |



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|  |                   |  |  |
|--|-------------------|--|--|
|  | speed of<br>15MPH |  |  |
|--|-------------------|--|--|

| <b>Time</b> | <b>Event</b> | <b>Correspondin<br/>g Cab Code<br/>Rate<br/><br/>Pulses      Per<br/>Minute</b> | <b>On Board Cab Signal Indication</b> |
|-------------|--------------|---|---------------------------------------|
|             | See Figure3  |   |                                       |



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|          |  |  |  |
|----------|--|--|--|
| 12:10:59 | Train 155 is occupying the south approach of the 6S signal on main track two. The 6S signal is indicating red. The On-board Cab signal code rate is 0 with an allowable speed of 0 MPH See figure -4 |  | <p><u>RDR-353 C. - No Code</u></p> <p><b>Indication/Procedure:</b> Train Operator must come to a complete stop and unless otherwise specified contact Control Center for instructions prior to moving the train. When permission has been granted, depress the stop/proceed button. Train Operator must then proceed at Restricted Speed until receiving a more favorable cab or fixed signal.</p> <p><b>Aspect:</b></p>    |
| 12:11:03 | Train 155 passes the 6S red signal and commits a stop signal violation occupying track 6A.   |  | <p><u>RDR-353 C. - No Code</u></p> <p><b>Indication/Procedure:</b> Train Operator must come to a complete stop and unless otherwise specified contact Control Center for instructions prior to moving the train. When permission has been granted, depress the stop/proceed button. Train Operator must then proceed at Restricted Speed until receiving a more favorable cab or fixed signal.</p> <p><b>Aspect:</b></p>  |

| Time | Event | Corresponding Cab Code Rate<br>Pulses Per Minute | On Board Cab Signal Indication |
|------|-------|--|--------------------------------|
|      |       |  |                                |


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|             |  |  |   |
|-------------|--|--|---|
| 12:11:08    | Train 155 occupies the 6B track Circuit. |  | <p><u>RDR-353 C. - No Code</u></p> <p><b>Indication/Procedure:</b> Train Operator must come to a complete stop and unless otherwise specified contact Control Center for instructions prior to moving the train. When permission has been granted, depress the stop/proceed button. Train Operator must then proceed at Restricted Speed until receiving a more favorable cab or fix signal.</p> <p><b>Aspect:</b></p>   |
| 12:11:10    | Train 155 occupies the 6C track.         |  | <p><u>RDR-353 C. - No Code</u></p> <p><b>Indication/Procedure:</b> Train Operator must come to a complete stop and unless otherwise specified contact Control Center for instructions prior to moving the train. When permission has been granted, depress the stop/proceed button. Train Operator must then proceed at Restricted Speed until receiving a more favorable cab or fix signal.</p> <p><b>Aspect:</b></p>  |
| <b>Time</b> | <b>Event</b>                             | <b>Corresponding Cab Code Rate</b><br><b>Pulses Per Minute</b> | <b>On Board Cab Signal Indication</b>   |

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|          |   |  |  |
|----------|---|--|--|
| 12:11:21 | Train 155 leaves the 6C track circuit and now occupies the A6T Track circuit which train 148 also occupies and train 155 strikes the standing train 148 |  | <p><u>RDR-353 C. - No Code</u></p> <p><b>Indication/Procedure:</b> Train Operator must come to a complete stop and unless otherwise specified contact Control Center for instructions prior to moving the train. When permission has been granted, depress the stop/proceed button. Train Operator must then proceed at Restricted Speed until receiving a more favorable cab or fixed signal.</p> <p><b>Aspect:</b></p>  |
|----------|---|--|--|

**3. Duplication of the Route of the striking Train**

The route was duplicated of the striking train 155 from the 1S signal at West Overbrook Interlocking to the 6S signal at 69<sup>th</sup> street. Each signal was photographed with the same aspect displayed as train 155 had on August 22, 2017.

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*Figure 1 Flashing Lunar 1S West Overbrook Interlocking*



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*Figure 2 Lunar 2S signal 69th Street Terminal*

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*Figure 3 Lunar 4S Signal 69th Street Terminal*





*Figure 4 6S Signal with Red aspect indicating stop with 0 Cab Code Rate*

#### **4. Post-accident ATC System Examination and Testing**

The post-accident examination found the signal equipment and appurtenances at the 1S signal at West Overbrook Interlocking and signals 2S, 4S, 6S at the 69<sup>th</sup> Street terminal secured with no indications of tampering or vandalism.

#### **5. Braking Chart**

On March 14, 2018, the S&TC group verified the track circuit lengths from the approach to 69<sup>th</sup> Street Interlocking on track #2 to the platform at 69<sup>th</sup> Street. Track circuits were verified near the accident for all tracks involved. Signal lamp voltages for the interlocking signals were recorded, and no exceptions were noted.

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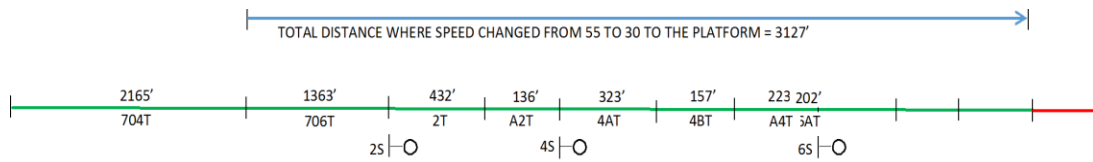


Figure 5 NHSL, Track circuit lengths

| Track Circuit | Track Circuit lengths on Signal Circuit Diagrams (feet) | Measured Track Circuit Lengths (feet) |
|---------------|---|---------------------------------------|
| 702T          | N/A   | 2028                                  |
| 704T          | 2158  | 2165                                  |
| 706T          | 1368  | 1363                                  |
| 2T            | 430   | 432                                   |
| A2T           | 157   | 136                                   |
| 4AT           | 323   | 323                                   |
| 4BT           | 156   | 157                                   |
| A4T           | 223   | 223                                   |
| 6AT           | 183   | 183                                   |
| 6BT           | 108   | 108                                   |
| 6CT           | 202   | 202                                   |
| A6T           | N/A   | --                                    |

Table 1. NHSL track circuit lengths.

## 6. ATC System Maintenance, Inspection and Test Records

ATC maintenance, inspection and test records reviewed for the 69<sup>th</sup> Street Interlocking. The records did not indicate any signal condition that would prevent the signal system from operating as intended. The maintenance records indicate all tests and inspections were completed in accordance with SEPTA standards.

Postaccident examination of signal 6S and signal operational tests indicated the system was functioning as designed.

## 7. Damages

The ATC system nor the third rail traction power system did not sustain damages because of the accident.